COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF INTERNAL AFFAIRS
WILLIAM S. LIVENGOOD, JR., *Secretary.*

TOPOGRAPHIC AND GEOLOGIC SURVEY
GEORGE H. ASHLEY, *State Geologist.*

SUMMIT GAS POOL FAYETTE COUNTY PENNSYLVANIA

By CHAS. R. FETTKE

10

CONTENTS

	Page
History	1
Subsurface stratigraphy	1
Records of wells	2
Log of Leo F. Heyn well	3
Log of John R. Thompson well	8
Structure	18
Reservoir rock	19
Production and reserves	19
Drilling costs	20
Other favorable structures	20
Acknowledgment	21
Figure 1. Map of Summit gas pool showing relation of wells to topography and structure	18

SUMMIT GAS POOL

FAYETTE COUNTY, PENNSYLVANIA

By Chas. R. Fettke

History

The Summit gas pool, opened in 1936, is under the crest of Chestnut Ridge in the vicinity of Summit, 4½ miles southeast of Uniontown. The pool, as developed at the end of 1939, occupies a narrow belt about 2½ miles long and 2,400 feet wide and, like the ridge, trends approximately N.30°E. The National Pike crosses the pool at Summit.

William E. Snee of West Elizabeth, Pennsylvania, was responsible for the discovery of the Summit pool. He became interested in the area in 1931, shortly after relatively large volumes of gas had been encountered in the Oriskany sandstone in the Wayne-Dundee and Tioga fields in south-central New York and north-central Pennsylvania, and started assembling a block of acreage in 1933. In 1935 he obtained the necessary financial cooperation to undertake exploration. The Potter Development Company, now the New Penn Development Corporation, of Port Allegany, Pennsylvania, joined him at that time in prospecting the Oriskany sandstone horizon for natural gas underneath the prominent dome along the Chestnut Ridge anticline in the vicinity of Summit. The first well was started on the Leo F. Heyn property at Summit in March 1935. Gas was encountered in August 1936 at a depth of 6,611 feet in the upper part of the cherty Onondaga formation which overlies the Oriskany sandstone at this locality.

Six producing wells and one dry hole have been completed in the pool. (See Figure 1.) A seventh well, the Sorg No. 2, is drilling (January 1940) and a location for the eighth well, Peoples Natural Gas Company Piedmont Coal Company No. 2, was made January 23, 1940. One deep test, Paul Dunham No. 1, drilled along the Chestnut Ridge anticline at Wymps Gap in the southwest corner of Wharton Township, got only a small flow of gas in the Onondaga formation. This well is about seven miles south of the nearest producing well in the Summit pool and is more than 1,000 feet lower on structure as measured on the top of the Onondaga formation. Although close to the axis of the anticline this well is far down on the southwestern nose of the Summit dome. The records of the above wells, including skeleton logs, are given in the following table: (page 2).

Three pipe lines serve the Summit pool (January 1940), namely, an 8-inch line, 28½ miles long, which connects with the Carnegie Natural Gas Company's system; a 4-inch line, 2½ miles long, which connects with the Manufacturers' Light and Heat Company's system; and a 4-inch line, 19½ miles long, which delivers gas to the plant of the L. J. Houze Convex Glass Company at Point Marion, Pennsylvania.

Subsurface stratigraphy

Complete sets of drill cutting samples have been studied by the writer from the Heyn No. 1 and the Thompson No. 1 wells and from a depth of 1,835 feet to the bottom of the Sorg No. 1. The upper 2,000 feet from the Indian Creek No. 1 and the upper 1,600 feet from Snee and Piedmont No. 1 have also been examined. The sample logs of the Heyn and Thompson wells, compiled from the studies, are given on page 3 and beyond.

RECORDS OF WELLS IN SUMMIT GAS POOL, FAYETTE COUNTY

Lessor	Name of Well	Alti-tude	Upper Devonian red beds			Tully		Onondaga			Oriskany		Total depth	Initial open flow	Initial pressure lbs. per sq. in.	Date completed
			Depth	Thickness	Interval to Tully	Depth	Thickness	Interval to Onondaga	Depth	Altitude	Thickness	Depth	Thickness			
Wm. E. Snee and New Penn Development Corporation	Leo F. Heyn No. 1	2316	355	400	5666	6021	79	551	6572	−4256	------	------	------	6690	1,800 M	3025 to 3050	4-23-37
ditto	Leo. F. Heyn No. 2	2464	------	------	------	6085	------	587	6672	−4208	------	------	------	6767	3,500 M	2985	3-24-38
Greensboro Gas Co.	John R. Thompson No. 1	2542	759	348	6001	6760	111	597	7357	−4815	199	7556	111	8159	Shot 7370-7420 show of gas	----------	8-12-38
Peoples Natural Gas Company	Piedmont Coal Company No. 1	2369	305	------	5605	5910	85	600	6510	−4141	199	6709	95	6825	2,600 M 6570-6709	2910	1-5-39
Wm. E. Snee and New Penn Development Corporation	Indian Creek Coal and Coke Company No. 1	2630	598	414	5642	6240	112	674	6914	−4284	189	7103	------	7147	928 M from Onondaga	2910	4-6-39
ditto	Piedmont Coal Company No. 1	2178	232	448	5828	6060	------	602	6662	−4484	------	------	------	------	2,000 M 1-9-40	----------	Drilling at 6799 1-9-40
W. W. Wasson et al.	Mrs. J. H. Sorg No. 1	2580	733	344	5668	6401	91	524	6925	−4345	184	7109	------	7114	1,900 M one-half from Oriskany	2980	3-10-39
L. J. Houze Convex Glass Company	Paul Dunham No. 1 [1]	2199	727	485	5960	6627	78	881	7508	−5309	190	7698	73	7826	50 to 200 M in Onondaga	----------	6-9-39

[1] James H. C. Martens, Petrography and correlation of deep-well sections in West Virginia and adjacent States: W. Va. Geol. Survey, 1939, pages 74-80.

M equals 1,000 cubic feet.

Log of William E. Snee and Potter Development Company's Leo F. Heyn No. 1 well, South Union Township, Fayette County, Pa., made from a study of drilling samples.

Elevation, 2,316 feet above sea-level.

Thickness Feet	Description of strata	Depth in feet Top	Depth in feet Bottom
	Lower Mississippian series, 140 feet		
40	Sandstone, fine- to medium-grained, yellowish-brown; weathered material overlying bedrock	0	40
40	Sandstone, very fine- to fine-grained, light greenish-gray to yellowish-brown	40	80
15	Sandstone, fine- to medium-grained, light greenish-gray to yellowish-brown	80	95
10	Sandstone, coarse, conglomeritic, greenish-gray; contains quartz pebbles 5 to 10 millimeters in diameter	95	105
20	Sandstone, medium-grained, light to dark greenish-gray	105	125
15	Sandstone, fine-grained, greenish-gray	125	140
	Upper Devonian series, 5,960 feet.		
5	Shale, greenish-gray	140	145
25	Sandstone, medium-grained, greenish-gray, with some interbedded gray shale in upper part	145	170
5	Sandstone, fine-grained, dark greenish-gray	170	175
5	Sandstone, medium-grained, greenish-gray, with some interbedded gray shale; a few quartz pebbles up to 10 millimeters in diameter present in sandstone	175	180
10	Sandstone, fine- to medium-grained, greenish-gray	180	190
10	Shale, gray	190	200
10	Sandstone, fine-grained, greenish-gray, with some interbedded gray shale	200	210
20	Siltstone, greenish to dark greenish-gray	210	230
35	Sandstone, fine-grained, greenish-gray, with a little interbedded gray shale	230	265
14	Sandstone, very fine-grained, greenish-gray, with some interbedded gray shale	265	279
6	Shale, gray	279	285
25	Sandstone, very fine-grained, dark greenish-gray	285	310
10	Sandstone, very fine-grained, dark greenish-gray, with some interbedded gray shale	310	320
17	Sandstone, very fine-grained, dark greenish-gray	320	337
18	Sandstone, very fine-grained, greenish-gray, slightly calcareous; muscovite abundant, some minute carbonized plant fragments	337	355
	Top of red beds at 355 feet.		
5	Shale, dark brick-red	355	360
5	Sandstone, very fine-grained, greenish-gray, micaceous	360	365
30	Sandstone, very fine-grained, dark greenish-gray	365	395
5	Shale, dark brick-red	395	400
5	Sandstone, very fine-grained, greenish-gray	400	405
5	Shale, brick-red	405	410
10	Shale, dark purplish-red, sandy	410	420
10	Sandstone, very fine-grained, greenish-gray	420	430
15	Shale, dark brick-red, sandy, with considerable interbedded greenish-gray sandy shale	430	445
10	Sandstone, very fine-grained, greenish-gray, micaceous,	445	455
15	Sandstone, very fine-grained, dark greenish-gray, micaceous, slightly calcareous	455	470
15	Sandstone, very fine-grained, greenish-gray, micaceous, slightly calcareous, with some interbedded gray shale	470	485
8	Shale, dark brick-red, with some interbedded greenish-gray sandy shale	485	493
3	Sandstone, very fine-grained, dark brick-red, somewhat calcareous	493	496
9	Sandstone, very fine-grained, dark greenish- and brownish-gray, somewhat calcareous	496	505

Thickness Feet	Description of strata	Depth in feet Top	Bottom
15	Shale, dark brick-red, sandy	505	520
5	Sandstone, very fine-grained, dark brick-red	520	525
15	Sandstone, very fine-grained, light to dark greenish-gray, somewhat calcareous	525	540
62	Shale, dark brick-red, sandy	540	602
12	Sandstone, very fine-grained, light greenish-gray	602	614
10	Shale, dark brick-red, sandy	614	624
30	Sandstone, very fine-grained, light greenish-gray, somewhat calcareous	624	654
8	Siltstone, dark reddish-brown	654	662
13	Sandstone, very fine-grained, dark reddish-brown	662	675
5	Shale, dark brick-red, sandy	675	680
7	Siltstone, greenish-gray, somewhat calcareous	680	687
5	Shale, greenish-gray, interbedded with dark brick-red shale	687	692
8	Sandstone, very fine-grained, light greenish-gray to dark reddish-brown	692	700
15	Shale, dark brick-red, sandy	700	715
9	Sandstone, very fine-grained, light greenish-gray	715	724
9	Shale, dark brick-red, sandy	724	733
13	Shale, greenish-gray, sandy	733	746
9	Shale, dark reddish-brown, sandy	746	755
	Bottom of red beds at 755 feet.		
10	Siltstone, light greenish-gray	755	765
33	Sandstone, fine-grained, light greenish-gray to white	765	798
23	Shale, greenish-gray	798	821
24	Sandstone, fine-grained, light gray to white; 4 bailers brackish water in 1½ hours and slight show of gas	821	845
176	Shale, greenish-gray	845	1021
87	Shale, greenish-gray, with some interbedded greenish-gray siltstone	1021	1108
14	Shale, gray	1108	1122
28	Siltstone, dark greenish-gray, with considerable interbedded gray shale	1122	1150
60	Shale, gray, with some interbedded greenish-gray siltstone	1150	1210
12	Siltstone, dark greenish-gray, with a little interbedded gray shale	1210	1222
12	Shale, dark gray, with a little interbedded dark greenish-gray and brownish-gray siltstone	1222	1234
64	Shale, gray, with some interbedded greenish-gray siltstone	1234	1298
52	Shale, greenish-gray, with some interbedded greenish-gray siltstone	1298	1350
10	Siltstone, greenish-gray, with some interbedded greenish-gray shale	1350	1360
6	Shale, gray	1360	1366
12	Siltstone, gray, with some interbedded gray shale	1366	1378
23	Shale, greenish-gray, with some interbedded greenish-gray siltstone	1378	1401
65	Shale, gray, with some interbedded greenish-gray siltstone	1401	1466
5	Sandstone, very fine-grained, greenish-gray	1466	1471
12	Shale, gray	1471	1483
10	Sandstone, very fine-grained, brownish- to greenish-gray	1483	1493
5	Shale, gray	1493	1498
10	Sandstone, very fine-grained, greenish-gray	1498	1508
18	Shale, gray, with some interbedded greenish-gray siltstone	1508	1526
6	Sandstone, fine- to medium-grained, light greenish-gray; contains some quartz pebbles to 5 millimeters in diameter	1526	1532
9	Sandstone, fine- to medium-grained, light brownish-gray with a little interbedded gray shale	1532	1541
7	Shale, gray	1541	1548
5	Siltstone, greenish-gray	1548	1553
6	Sandstone, very fine-grained, greenish- to very dark gray	1553	1559
4	Siltstone, greenish-gray	1559	1563
34	Shale, gray, with a little interbedded greenish-gray siltstone	1563	1597
11	Sandstone, very fine-grained, dark grayish-brown, micaceous	1597	1608

Thickness Feet	Description of strata	Depth in feet Top	Bottom
22	Siltstone, dark brownish-gray with considerable interbedded gray shale	1608	1630
6	Sandstone, very fine-grained, greenish-gray	1630	1636
41	Shale, gray	1636	1677
18	Sandstone, very fine-grained, gray to brownish-gray, with a little interbedded gray shale	1677	1695
45	Shale, gray, with some interbedded gray to dark brownish-gray siltstone	1695	1740
7	Sandstone, very fine-grained, dark brownish-gray	1740	1747
45	Shale, gray, with some interbedded greenish-gray siltstone	1747	1792
5	Sandstone, very fine-grained, brownish-gray	1792	1797
80	Shale, gray, with some interbedded greenish-gray siltstone; minute fragments of carbonized plant remains, 1846-1857	1797	1877
40	Shale, greenish-gray	1877	1917
14	Shale, greenish-gray, sandy	1917	1931
83	Siltstone, greenish-gray, somewhat calcareous, with some interbedded gray shale; fragments of shells in siltstone	1931	2014
15	Sandstone, fine- to very fine-grained, greenish-gray, somewhat calcareous	2014	2029
7	Shale, gray	2029	2036
5	Sandstone, very fine-grained, greenish-gray, slightly calcareous	2036	2041
44	Shale, gray	2041	2085
10	Siltstone, greenish-gray, somewhat calcareous, with some interbedded gray shale; fragments of shells in siltstone	2085	2095
5	Shale, gray	2095	2100
7	Siltstone, greenish-gray; contains fragments of shells	2100	2107
9	Shale, gray	2107	2116
5	Siltstone, greenish-gray; contains minute fragments of carbonized plant remains	2116	2121
36	Shale, gray	2121	2157
39	Shale, gray with some interbedded gray siltstone; fragments of shells in siltstone	2157	2196
22	Shale, gray	2196	2218
12	Shale, greenish-gray, sandy, slightly calcareous; contains fragments of shells	2218	2230
42	Shale, gray, with some interbedded greenish-gray siltstone; fragments of shells in siltstone	2230	2272
13	Sandstone, very fine-grained, very dark brownish-gray, somewhat calcareous; contains fragments of shells	2272	2285
5	Siltstone, greenish-gray, slightly calcareous	2285	2290
17	Shale, very dark gray, sandy	2290	2307
11	Siltstone, greenish-gray, somewhat calcareous, with some interbedded gray shale; siltstone contains fragments of shells	2307	2318
23	Shale, gray, with some interbedded greenish-gray siltstone	2318	2341
39	Siltstone, greenish-gray, somewhat calcareous, with some interbedded gray shale; fragments of shells in siltstone	2341	2380
12	Sandstone, very fine-grained, dark brownish-gray, somewhat calcareous; contains fragments of shells	2380	2392
80	Siltstone, greenish-gray, somewhat calcareous, with some interbedded gray shale; fragments of shells in siltstone	2392	2472
29	Siltstone, greenish-gray, somewhat calcareous; contains fragments of shells	2472	2501
12	Siltstone, greenish- to dark brownish-gray	2501	2513
49	Siltstone, greenish-gray, with some interbedded gray shale	2513	2562
34	Shale, gray, with some interbedded greenish-gray siltstone	2562	2596
6	Sandstone, very fine-grained, dark brownish-gray	2596	2602
5	Siltstone, gray, somewhat calcareous	2602	2607
28	Siltstone, gray, with considerable interbedded gray shale; fragments of shells in siltstone	2607	2635
5	Shale, greenish-gray, sandy	2635	2640
78	Shale, dark gray, with some interbedded gray siltstone and sandy shale; fragments of shells observed 2661-2668	2640	2718
5	Sandstone, very fine-grained, gray, slightly calcareous	2718	2723

Thickness Feet	Description of strata	Depth in feet Top	Bottom
58	Shale, gray to dark gray, with some interbedded gray siltstone and sandy shale	2723	2781
12	Sandstone, very fine-grained, light greenish-gray, slightly calcareous, with some interbedded gray shale	2781	2793
5	Shale, gray	2793	2798
24	Siltstone, greenish-gray, with some interbedded gray shale	2798	2822
16	Shale, gray, with some interbedded greenish-gray siltstone	2822	2838
18	Siltstone, gray, with some interbedded gray shale	2838	2856
15	Shale, gray, with some interbedded gray siltstone	2856	2871
6	Siltstone, greenish-gray, with some interbedded gray shale	2871	2877
5	Sandstone, very fine-grained, light greenish-gray, with some interbedded gray shale	2877	2882
6	Siltstone, greenish-gray, with some interbedded gray shale	2882	2888
6	Sandstone, very fine-grained, light greenish-gray, with some interbedded gray shale	2888	2894
12	Siltstone, greenish-gray with some interbedded gray shale	2894	2906
17	Sandstone, very fine-grained, light greenish-gray, with a little interbedded gray shale	2906	2923
5	Siltstone, gray, with some interbedded gray shale	2923	2928
29	Shale, gray, with some interbedded gray siltstone	2928	2957
18	Shale, gray	2957	2975
10	Shale, gray, sandy	2975	2985
29	Siltstone, gray, slightly calcareous, with some interbedded gray shale	2985	3014
12	Sandstone, very fine-grained, light gray, with some interbedded gray shale	3014	3026
45	Shale, dark gray, with a little interbedded gray siltstone	3026	3071
52	Shale, dark to very dark gray	3071	3123
22	Siltstone, gray with a little interbedded dark gray shale	3123	3145
12	Sandstone, very fine-grained, greenish-gray, slightly calcareous	3145	3157
12	Siltstone, greenish-gray, with some interbedded gray shale	3157	3169
16	Shale, gray, with some interbedded greenish-gray siltstone	3169	3185
35	Siltstone, greenish-gray, with some interbedded gray shale	3185	3220
17	Shale, gray, sandy, with some interbedded greenish-gray siltstone	3220	3237
16	Siltstone, greenish-gray, with a little interbedded gray shale	3237	3253
6	Shale, gray	3253	3259
18	Siltstone, gray, somewhat calcareous, with some interbedded gray shale; fragments of shells in siltstone	3259	3277
30	Shale, gray	3277	3307
13	Siltstone, gray, with some interbedded gray shale	3307	3320
10	Shale, gray, sandy	3320	3330
5	Sandstone, very fine-grained, light greenish-gray	3330	3335
41	Shale, gray, sandy	3335	3376
6	Sandstone, very fine-grained, dark brownish-gray, slightly calcareous	3376	3382
6	Shale, dark gray, sandy	3382	3388
18	Shale, gray, with some interbedded greenish-gray siltstone	3388	3406
53	Shale, gray	3406	3459
6	Siltstone, gray	3459	3465
26	Shale, gray	3465	3491
12	Shale, gray, with some interbedded very fine-grained, greenish-gray sandstone; fragments of shells in sandstone	3491	3503
34	Sandstone, very fine-grained, greenish-gray to very dark gray; contains fragments of shells	3503	3537
12	Shale, gray	3537	3549
11	Shale, gray, with some interbedded very fine-grained, greenish-gray sandstone	3549	3560
48	Shale, gray, sandy	3560	3608
60	Shale, gray, with some interbedded gray sandy shale	3608	3668
14	Shale, gray; contains a few fragments of shells	3668	3682
8	Sandstone, very fine-grained, dark brownish-gray, slightly calcareous	3682	3690
8	Shale, dark gray	3690	3698
7	Sandstone, very fine-grained, very dark brownish-gray	3698	3705

Thickness Feet	Description of strata	Depth in feet Top	Bottom
10	Shale, gray, with some interbedded very fine-grained, very dark brownish-gray sandstone	3705	3715
10	Shale, gray, with some interbedded very fine-grained, greenish-gray sandstone	3715	3725
33	Shale, gray, sandy	3725	3758
22	Shale, gray; contains a few fragments of shells in upper part	3758	3780
20	Shale, gray, with some interbedded gray sandy shale	3780	3800
37	Shale, gray	3800	3837
30	Shale, dark gray	3837	3867
17	Shale, gray, with some interbedded gray sandy shale	3867	3884
26	Shale, gray	3884	3910
5	Shale, dark gray	3910	3915
17	Shale, gray	3915	3932
5	Shale, gray, sandy; contains a few fragments of shells	3932	3937
5	Shale, very dark gray	3937	3942
6	Shale, gray, sandy	3942	3948
6	Sandstone, very fine-grained, light gray	3948	3954
46	Shale, gray, sandy	3954	4000
19	Shale, gray, with some interbedded gray sandy shale	4000	4019
54	Shale, gray	4019	4073
221	Shale, dark gray	4073	4294
56	Shale, dark gray, with a little interbedded greenish-gray siltstone	4294	4350
66	Shale, dark gray, with some interbedded greenish-gray sandy shale	4350	4416
51	Shale, very dark gray, with some interbedded gray sandy shale	4416	4467
28	Shale, dark gray, with some interbedded gray sandy shale: a few fragments of shells in sandy shale	4467	4495
12	Shale, grayish-black, with some interbedded gray shale	4495	4507
33	Shale, gray to dark gray, with some interbedded gray sandy shale	4507	4540
32	Shale, dark to very dark gray	4540	4572
43	Shale, dark gray, with some interbedded gray sandy shale	4572	4615
22	Shale, dark gray	4615	4637
109	Shale, dark gray, with a little interbedded gray sandy shale	4637	4746
184	Shale, gray, sandy, with some interbedded dark gray shale	4746	4930
216	Shale, dark gray, with some interbedded gray sandy shale	4930	5146
21	Shale, dark gray, with some interbedded grayish black shale and gray sandy shale	5146	5167
60	Shale, dark to very dark gray	5167	5227
53	Shale, dark gray, with a little interbedded very fine-grained gray sandstone; an open flow of 40 to 50 thousand cubic feet of gas encountered between 5232 and 5239 feet	5227	5280
46	Shale, very dark gray	5280	5326
13	Shale, grayish black, with some interbedded dark gray shale	5326	5339
36	Shale, very dark gray	5339	5375
139	Shale, very dark gray, with some interbedded dark gray sandy shale	5375	5514
86	Shale, very dark gray, with a little interbedded dark gray sandy shale	5514	5600
12	Shale, very dark gray, with a little interbedded grayish-black shale	5600	5612
16	Shale, very dark gray, with a little interbedded dark gray sandy shale	5612	5628
7	Shale, very dark gray, with some interbedded grayish-black shale	5628	5635
17	Shale, very dark gray, with a little interbedded dark gray sandy shale	5635	5652
10	Shale, very dark gray, with some interbedded grayish-black shale and dark gray sandy shale	5652	5662
20	Shale, grayish-black, with considerable interbedded very dark gray shale	5662	5682
23	Shale, grayish-black, with a little interbedded very dark gray shale	5682	5705

Thickness Feet	Description of strata	Depth in feet Top	Bottom
220	Shale, grayish-black	5705	5925
61	Shale, grayish-black, somewhat calcareous	5925	5986
35	Shale, grayish-black, slightly calcareous	5986	6021
	Tully limestone, 79 feet		
44	Limestone, very fine, dense, dark brownish-gray, argillaceous	6021	6065
3	Shale, very dark gray, calcareous	6065	6068
5	Limestone, very fine, dense, dark brownish-gray, argillaceous	6068	6073
5	Shale, very dark gray, calcareous	6073	6078
16	Limestone, very fine, dense, dark brownish-gray, argillaceous	6078	6094
6	Shale, very dark gray, calcareous with some interbedded very fine, dense, dark brownish-gray, argillaceous limestone	6094	6100
	Bottom of Upper Devonian series at 6100 feet		
	Middle Devonian series, 590+ feet		
	Hamilton group, 472 feet		
12	Shale, very dark gray, calcareous	6100	6112
223	Shale, grayish-black, with a little interbedded very dark gray shale	6112	6335
97	Shale, grayish-black	6335	6432
78	Shale, black; contains considerable pyrite in form of minute crystals and grains and some calcite veinlets	6432	6510
61	Shale, black, somewhat calcareous; contains pyrite	6510	6571
1	Shale, brown, micaceous; contains pyrite	6571	6572
	Onondaga formation, 118+ feet		
21	Limestone, very dark grayish-brown, almost black, argillaceous	6572	6593
9	Chert, light to dark brownish-gray, somewhat calcareous; contains considerable glauconite	6593	6602
7	Chert, light to dark brownish-gray, somewhat calcareous	6602	6609
41	Chert, light to dark brownish-gray, somewhat silty, somewhat calcareous; some glauconite in lower part; first gas encountered at 6611 feet	6609	6650
17	Chert, dark brownish-gray, slightly calcareous	6650	6667
	Original total depth, 6667; well later deepened in chert to		6690

Log of Greensboro Gas Company's well No. 910, John R. Thompson farm, Wharton Township, Fayette County, Pa., made from a study of drilling samples.

Elevation, 2,542 feet above sea-level.

	Lower Mississippian series, 481 feet		
112	No samples	0	112
11	Sandstone, fine-grained, greenish-gray, micaceous	112	123
6	Siltstone, dark greenish-gray, micaceous	123	129
60	Sandstone, fine-grained, light greenish-gray, somewhat micaceous	129	189
6	Shale, very dark brownish-gray, almost black, sandy	189	195
7	Sandstone, medium to coarse-grained, light greenish-gray; contains quartz grains up to 5 mm. in diameter	195	202
6	Shale, very dark gray	202	208
29	Sandstone, medium-grained, light greenish-gray, with some interbedded brownish-black shale	208	237
6	Sandstone, medium to coarse-grained, light gray, with some interbedded very dark gray shale	237	243
4	Sandstone, fine to medium-grained, light gray, with some interbedded grayish-black shale	243	247
5	Shale, dark gray, sandy	247	252
5	Sandstone, fine-grained, greenish-gray, calcareous, with some interbedded dark gray sandy shale	252	257
5	Sandstone, fine-grained, light greenish-gray, slightly calcareous	257	262
46	Shale, dark gray, sandy	262	308
10	Shale, dark gray, sandy, with some interbedded very fine-grained, dark greenish-gray sandstone	308	318
14	Sandstone, fine to medium-grained, light grayish-brown, with a little interbedded dark gray sandy shale	318	332

Thickness Feet	Description of strata	Depth in feet Top	Bottom
28	Sandstone, fine to medium-grained, light to brownish to brownish-gray, with some interbedded dark gray and black shale	332	360
21	Shale, greenish gray, sandy	360	381
8	Siltstone, dark greenish-gray	381	389
11	Shale, gray	389	400
9	Siltstone, dark gray	400	409
19	Sandstone, fine-grained, greenish to very dark gray, somewhat calcareous	409	428
10	Sandstone, fine to medium-grained, greenish-gray; contains occasional quartz grains up to 2 mm. in diameter	428	438
13	Sandstone, fine to medium-grained, light gray; contains a little muscovite	438	451
20	Sandstone, medium to coarse-grained, light gray, with a little interbedded gray shale; sandstone contains a few quartz grains up to 2 mm. in diameter	451	471
10	Sandstone, medium-grained, light gray, slightly calcareous	471	481
	Upper Devonian series, 6390 feet		
3	Sandstone, very fine-grained, dark greenish-gray, with a little interbedded dark greenish-gray shale	481	484
6	Sandstone, very fine-grained, greenish-gray, with some interbedded very dark gray shale	484	490
17	Sandstone, fine-grained, light greenish-gray; contains some muscovite	490	507
4	Shale, very dark gray	507	511
14	Sandstone, fine-grained, greenish-gray, with some interbedded dark gray, sandy shale	511	525
11	Sandstone, fine-grained, light gray	525	536
10	Shale, dark gray, sandy, slightly calcareous	536	546
11	Sandstone, fine-grained, light greenish-gray	546	557
32	Sandstone, very fine-grained, greenish-gray, slightly calcareous	557	589
10	Sandstone, very fine-grained, greenish-gray, with some interbedded gray shale	589	599
6	Sandstone, very fine-grained, very dark grayish-brown; contains muscovite	599	605
6	Sandstone, very fine-grained, greenish-gray	605	611
5	Shale, gray	611	616
6	Sandstone, fine-grained, dark greenish-gray	616	622
5	Shale, gray	622	627
9	Sandstone, very fine-grained, dark greenish-gray, slightly calcareous, with a little interbedded gray shale	627	636
11	Shale, gray, with some interbedded very fine-grained, dark greenish-gray, slightly calcareous sandstone	636	647
43	Sandstone, very fine-grained, greenish-gray, slightly calcareous, with some interbedded gray shale	647	690
15	Sandstone, very fine-grained, dark to very dark greenish-gray	690	705
8	Sandstone, very fine-grained, very dark greenish-gray, with considerable interbedded dark gray shale	705	713
16	Sandstone, very fine-grained, dark greenish-gray, with a little interbedded dark gray shale	713	729
30	Sandstone, very fine-grained, dark greenish- and brownish-gray	729	759
	Top of red beds at 759 feet		
6	Shale, brick-red, with some interbedded greenish-gray sandy shale	759	765
19	Shale, brick-red, sandy, with considerable interbedded greenish-gray sandy shale	765	784
8	Shale, brick-red, with a little interbedded very fine-grained greenish-gray sandstone	784	792
12	Shale, brick-red, sandy, with some interbedded greenish-gray sandy shale	792	804
14	Sandstone, very fine-grained, brick-red, very slightly calcareous; contains some muscovite	804	818
8	Sandstone, fine-grained, greenish-gray; contains muscovite	818	826
4	Shale, greenish-gray, sandy, very slightly calcareous	826	830

Thickness Feet	Description of strata	Depth in feet Top	Bottom
15	Sandstone, very fine-grained, brick-red, slightly calcareous ..	830	845
9	Sandstone, very fine-grained, greenish-gray; contains some muscovite	845	854
9	Shale, brick-red, in part sandy	854	863
13	Sandstone, very fine-grained, brick-red, slightly calcareous; contains muscovite	863	876
22	Shale, brick-red, sandy, micaceous	876	898
6	Sandstone, very fine-grained, greenish-gray	898	904
18	Shale, brick-red, sandy, micaceous	904	922
23	Sandstone, very fine-grained, light grayish-green, slightly calcareous, with a little interbedded brick-red sandy shale	922	945
24	Sandstone, very fine-grained, greenish-gray; contains some muscovite	945	969
5	Shale, brick-red, sandy, micaceous	969	974
5	Sandstone, very fine-grained, greenish-gray, slightly calcareous, with some interbedded dark gray shale	974	979
30	Shale, brick-red, sandy, micaceous, with a little interbedded very fine-grained, greenish-gray sandstone	979	1009
6	Sandstone, very fine-grained, brick-red, slightly calcareous; contains some muscovite	1009	1015
22	Shale, brick-red, sandy, with some interbedded greenish-gray sandy shale	1015	1037
16	Shale, brick-red, micaceous	1037	1053
14	Sandstone, very fine-grained, brick-red, micaceous	1053	1067
17	Sandstone, very fine-grained, brick-red, micaceous, with some interbedded very fine-grained, greenish-gray, slightly calcareous sandstone	1067	1084
23	Sandstone, very fine-grained, brick-red, micaceous	1084	1107
	Bottom of red beds at 1107 feet		
14	Sandstone, fine-grained, light greenish-gray	1107	1121
13	Shale, gray, with considerable interbedded fine-grained, light greenish-gray sandstone	1121	1134
10	Sandstone, fine-grained, dark greenish-gray	1134	1144
7	Shale, gray, with some interbedded very fine-grained, greenish-gray sandstone	1144	1151
7	Sandstone, very fine-grained. greenish-gray, with some interbedded gray shale and a little brick-red shale	1151	1158
16	Sandstone, medium to coarse-grained, light greenish-gray to white; contains quartz grains up to 2 mm. in diameter	1158	1174
21	Shale. gray	1174	1195
17	Sandstone, fine-grained, grayish-brown. with a little interbedded very fine-grained, brick-red sandstone	1195	1212
50	Shale, gray	1212	1262
21	Siltstone, dark greenish-gray, with some interbedded dark gray shale	1262	1283
9	Shale, dark gray	1283	1292
10	Siltstone, dark greenish-gray, with some interbedded dark gray shale	1292	1302
79	Shale, dark gray, with some interbedded dark greenish-gray siltstone; fragments of shells in siltstone at 1324-1331 and some fragments of carbonized plant remains in lower part	1302	1381
13	Siltstone, dark greenish-gray. with some interbedded dark gray shale; abundant carbonized plant fragments in siltstone	1381	1394
15	Shale, dark gray, with some interbedded dark greenish-gray siltstone	1394	1409
33	Shale, dark gray	1409	1442
6	Siltstone, dark greenish-gray	1442	1448
6	Sandstone, very fine-grained, dark greenish-gray	1448	1454
24	Siltstone, dark greenish-gray, with some interbedded dark gray shale	1454	1478
4	Sandstone, very fine-grained. dark greenish-gray	1478	1482
35	Siltstone, dark greenish-gray, with some interbedded dark gray shale	1482	1517

Thickness Feet	Description of strata	Depth in feet Top	Bottom
11	Shale, dark gray, with some interbedded dark greenish- and brownish-gray siltstone	1517	1528
9	Siltstone, dark greenish-gray	1528	1537
5	Shale, dark gray	1537	1542
6	Sandstone, very fine-grained, greenish-gray	1542	1548
40	Shale, dark gray, with some interbedded greenish-gray siltstone	1548	1588
28	Sandstone, very fine-grained, light greenish-gray, with some interbedded dark gray shale	1588	1616
26	Shale, gray, with some interbedded greenish-gray siltstone	1616	1642
36	Shale, dark gray	1642	1678
8	Sandstone, very fine-grained, greenish-gray	1678	1686
60	Shale, dark gray, with some interbedded greenish-gray siltstone	1686	1746
9	Sandstone, very fine-grained, greenish-gray	1746	1755
8	Sandstone, very fine-grained, very dark brownish-gray	1755	1763
27	Shale, dark gray	1763	1790
21	Sandstone, very fine-grained, dark gray, with considerable interbedded dark gray shale	1790	1811
9	Shale, dark gray	1811	1820
8	Sandstone, very fine-grained, greenish-gray, slightly calcareous	1820	1828
36	Shale, gray	1828	1864
14	Sandstone, coarse-grained, gray, slightly calcareous; contains quartz grains up to 2 mm. in diameter	1864	1880
37	Shale, gray to dark gray, with a little interbedded dark gray siltstone	1880	1917
19	Sandstone, fine to medium-grained, dark gray, with a little interbedded dark gray shale	1917	1936
42	Shale, gray to dark gray, with a little interbedded fine-grained, very dark gray sandstone	1936	1978
18	Shale, greenish-gray	1978	1996
18	Sandstone, very fine-grained, very dark brownish-gray, with a little interbedded greenish-gray shale	1996	2014
22	Shale, dark gray with a little interbedded very fine-grained, greenish-gray sandstone	2014	2036
37	Shale, greenish-gray, with a little fine-grained greenish-gray sandstone	2036	2073
21	Sandstone, fine-grained, brownish-gray, with some interbedded gray shale	2073	2094
40	Shale, gray to dark gray, with some interbedded fine- to medium-grained, greenish- to brownish-gray sandstone	2094	2134
19	Sandstone, fine- to medium-grained, dark brownish-gray, with some interbedded dark gray shale	2134	2153
30	Shale, dark gray, with a little interbedded very fine-grained, greenish-gray sandstone	2153	2183
17	Sandstone, very fine-grained, greenish-gray, slightly calcareous, with some interbedded dark gray shale containing fragments of carbonized plant remains	2183	2200
98	Shale, gray, with a little interbedded very fine-grained, greenish-gray sandstone	2200	2298
10	Sandstone, very fine-grained, greenish-gray, slightly calcareous	2298	2308
20	Shale, dark gray, with a little interbedded very fine-grained dark brownish-gray sandstone	2308	2328
11	Shale, gray, with considerable interbedded greenish-gray siltstone containing fragments of shells	2328	2339
16	Sandstone, very fine-grained, greenish-gray, somewhat calcareous, with some interbedded gray shale; sandstone contains fragments of shells	2339	2355
9	Shale, gray	2355	2364
19	Siltstone, greenish-gray, slightly calcareous, with some interbedded gray shale; siltstone contains fragments of shells	2364	2383
5	Sandstone, very fine-grained, greenish-gray, somewhat calcareous; contains fragments of shells	2383	2388
10	Shale, gray	2388	2398
23	Siltstone, greenish-gray, somewhat calcareous, with a little interbedded gray shale; siltstone contains fragments of shells	2398	2421

Thickness Feet	Description of strata	Depth in feet Top	Bottom
19	Sandstone, fine to medium-grained, light brownish-gray, somewhat calcareons; contains muscovite	2421	2440
49	Shale, dark gray	2440	2489
55	Shale, gray, with a little interbedded greenish-gray siltstone containing fragments of shells	2489	2544
27	Shale, gray	2544	2571
19	Shale, greenish-gray, sandy with some interbedded gray shale	2571	2590
19	Shale, dark gray, with a little interbedded greenish-gray, slightly calcareous siltstone	2590	2609
15	Siltstone, very dark brownish-gray, almost black, slightly calcareous	2609	2624
14	Siltstone, greenish-gray, somewhat calcareous, with some interbedded dark gray shale; fragments of shells in siltstone	2624	2638
55	Shale, gray, with some interbedded greenish-gray, somewhat calcareous siltstone containing fragments of shells	2638	2693
18	Siltstone, greenish-gray, somewhat calcareous; contains fragments of shells	2693	2711
20	Shale, dark gray, with some interbedded greenish-gray siltstone containing fragments of shells	2711	2731
54	Shale, greenish-gray, sandy, with some interbedded dark gray shale; sandy shale contains fragments of shells	2731	2785
36	Siltstone, dark greenish- and brownish-gray; contains fragments of shells	2785	2821
3	Sandstone, very fine-grained, very dark gray, almost black, micaceous and slightly calcareous	2821	2824
13	Siltstone, greenish-gray, somewhat calcareous, with some interbedded dark gray shale; siltstone contains fragments of shells	2824	2837
48	Shale, dark greenish-gray, sandy; contains fragments of shells	2837	2885
9	Siltstone, very dark greenish-gray	2885	2894
11	Sandstone, very fine-grained, greenish to dark greenish-gray, somewhat calcareous	2894	2905
34	Shale, gray, with some interbedded dark gray siltstone	2905	2939
7	Sandstone, very fine-grained, greenish-gray	2939	2946
8	Shale, gray	2946	2954
7	Sandstone, very fine-grained, greenish-gray	2954	2961
50	Shale, gray to dark gray, with a little interbedded greenish-gray siltstone	2961	3011
16	Sandstone, very fine-grained, greenish-gray, somewhat calcareous, with a little interbedded gray shale	3011	3027
10	Shale, gray	3027	3037
10	Sandstone, very fine-grained, greenish-gray, slightly calcareous, with some interbedded dark gray shale	3037	3047
21	Shale, dark gray, with some interbedded greenish-gray siltstone; contains fragments of shells	3047	3068
10	Siltstone, dark gray, somewhat calcareous	3068	3078
24	Shale, dark gray, with a little interbedded dark greenish-gray siltstone	3078	3102
10	Siltstone, greenish-gray, with some interbedded dark gray shale	3102	3112
8	Sandstone, very fine-grained, greenish-gray, with considerable interbedded dark gray shale	3112	3120
70	Shale, dark gray, with some interbedded greenish-gray siltstone	3120	3190
20	Sandstone, very fine-grained, gray to very dark gray, slightly calcareous	3190	3210
15	Siltstone, gray	3210	3225
55	Shale, dark gray, with some interbedded greenish-gray siltstone	3225	3280
6	Shale, dark greenish-gray, sandy, somewhat calcareous	3280	3286
30	Shale, dark gray, with some interbedded dark greenish-gray siltstone	3286	3316
9	Shale, dark gray, sandy	3316	3325
7	Sandstone, very fine-grained, greenish-gray to dark gray; contains fragments of shells	3325	3332
10	Siltstone, dark greenish-gray, slightly calcareous	3332	3342
10	Shale, dark gray	3342	3352

Thickness Feet	Description of strata	Depth in feet Top	Bottom
38	Shale, dark greenish-gray, sandy	3352	3390
7	Sandstone, very fine-grained, greenish-gray; contains fragments of shells	3390	3397
17	Shale, gray to dark gray	3397	3414
10	Sandstone, very fine-grained, greenish-gray to very dark gray, slightly calcareous	3414	3424
73	Shale, dark gray, with a little interbedded very fine-grained greenish-gray, somewhat calcareous sandstone; sandstone contains fragments of shells	3424	3497
41	Shale, dark to very dark gray	3497	3538
18	Sandstone, very fine-grained, light greenish-gray, slightly calcareous, with some interbedded dark gray shale	3538	3556
7	Shale, greenish-gray, sandy	3556	3563
41	Sandstone, very fine-grained, greenish-gray, with some interbedded dark gray shale	3563	3604
21	Shale, gray, sandy	3604	3625
9	Siltstone, gray; contains fragments of shells	3625	3634
8	Shale, gray, sandy	3634	3642
13	Sandstone, very fine-grained, greenish- to dark greenish-gray, somewhat calcareous, with some interbedded dark gray shale	3642	3655
28	Shale, dark gray, with considerable interbedded, very fine-grained, greenish-gray sandstone	3655	3683
32	Shale, dark gray, with a little interbedded very fine-grained, greenish-gray sandstone; sandstone contains fragments of shells	3683	3715
15	Shale, gray, sandy	3715	3730
17	Shale, gray, with some interbedded very fine-grained, light greenish-gray sandstone; fragments of shells in sandstone	3730	3747
48	Shale, greenish-gray, sandy, with some interbedded gray to dark gray shale; fragments of shells in sandy shale	3747	3795
49	Shale, dark gray, with a little interbedded very fine-grained, greenish-gray sandstone; fragments of shells in sandstone	3795	3844
18	Shale, gray, contains carbonized fragments of plants	3844	3862
41	Shale, gray to greenish-gray, sandy, with considerable interbedded dark gray shale; fragments of shells in sandy shale	3862	3903
47	Sandstone, very fine-grained, very dark greenish- and brownish-gray, somewhat calcareous, with a little interbedded gray shale; fragments of shells in sandstone	3903	3950
28	Shale, gray, with some interbedded greenish-gray siltstone	3950	3978
6	Sandstone, very fine-grained, greenish-gray, slightly calcareous, with some interbedded dark gray shale	3978	3984
10	Shale, dark gray, with some interbedded greenish-gray, sandy shale; fragments of shells in sandy shale	3984	3994
6	Shale, gray	3994	4000
10	Siltstone, greenish-gray	4000	4010
98	Shale, gray, with a little interbedded gray sandy shale and very fine-grained sandstone; fragments of shells in sandy shale and sandstone	4010	4108
10	Shale, brownish-black	4108	4118
38	Shale, dark gray, with some interbedded dark brownish-black sandy shale	4118	4156
16	Shale, gray, sandy, with some interbedded dark gray shale	4156	4172
78	Shale, dark gray, with a little interbedded greenish-gray sandy shale	4172	4250
34	Shale, dark gray	4250	4284
24	Shale, dark gray, with a little interbedded greenish-gray sandy shale	4284	4308
10	Shale, dark gray, sandy	4308	4318
15	Shale, dark gray, with a little interbedded greenish-gray, sandy shale	4318	4333
17	Shale, gray, with a little interbedded greenish-gray siltstone	4333	4350
68	Shale, dark gray, with a little interbedded greenish-gray siltstone	4350	4418
7	Shale, very dark brownish-gray, sandy	4418	4425
29	Shale, dark gray, with some interbedded greenish-gray siltstone	4425	4454
46	Shale, dark gray	4454	4500

Thickness Feet	Description of strata	Depth in feet Top	Bottom
59	Shale, dark gray, with a little interbedded gray siltstone	4500	4559
19	Shale, dark gray	4559	4578
84	Shale, very dark gray	4578	4662
56	Shale, dark gray, with a little interbedded gray siltstone	4662	4718
14	Shale, gray, sandy, with some interbedded gray shale	4718	4732
47	Shale, dark gray, with some interbedded gray sandy shale; carbonized fragments of plants in shale	4732	4779
16	Shale, dark gray	4779	4795
70	Shale, dark gray, with a little interbedded gray sandy shale	4795	4865
36	Shale, very dark gray, with a little interbedded gray siltstone	4865	4901
25	Shale, dark gray	4901	4926
8	Shale, very dark gray	4926	4934
8	Shale, grayish black	4934	4942
230	Shale, dark gray	4942	5172
27	Shale, dark gray, with a little interbedded gray sandy shale	5172	5199
68	Shale, dark gray	5199	5267
40	Shale, dark gray, with a little interbedded gray siltstone	5267	5307
49	Shale, greenish-gray, sandy, with some interbedded dark gray shale	5307	5356
22	Shale, dark gray, with some interbedded greenish-gray sandy shale	5356	5378
103	Shale, dark gray, with a little interbedded gray sandy shale containing fragments of shells	5378	5481
29	Shale, gray, sandy, with some interbedded dark gray shale	5481	5510
92	Shale, dark to very dark gray, with some interbedded gray sandy shale	5510	5602
58	Shale, dark gray, with a little interbedded gray, sandy shale	5602	5660
61	Shale, dark to very dark gray	5660	5721
485	No samples	5721	6206
8	Shale, dark gray, with some interbedded grayish-black shale	6206	6214
21	Shale, dark gray	6214	6235
33	Shale, very dark gray	6235	6268
8	Shale, grayish- and brownish-black, slightly calcareous	6268	6276
19	Shale, very dark gray	6276	6295
7	Shale, grayish-black	6295	6302
17	Shale, very dark gray, with some interbedded grayish-black shale	6302	6319
49	Shale, grayish-black	6319	6368
26	Shale, black, slightly calcareous	6368	6394
110	Shale, grayish-black	6394	6504
4	Shale, very dark gray	6504	6508
19	Shale, grayish-black	6508	6527
4	Shale, dark gray	6527	6531
92	Shale, grayish-black	6531	6623
11	Shale, grayish-black	6623	6634
126	Shale, black	6634	6760
	Tully limestone, 111 feet		
34	Limestone, very fine, dense, very dark brownish-gray, argillaceous	6760	6794
5	Shale, very dark gray, very calcareous	6794	6799
6	Limestone, very fine, dense, very dark brownish-gray, argillaceous	6799	6805
6	Shale, very dark gray, very calcareous	6805	6811
29	Limestone, very fine, dense, very dark brownish-gray, argillaceous	6811	6840
7	Shale, grayish-black, calcareous	6840	6847
24	Limestone, very fine, dense, very dark brownish-gray, argillaceous	6847	6871
	Middle Devonian series, 685 feet		
	Hamilton group, 486 feet		
27	Shale, grayish-black to black, calcareous	6871	6898
31	Shale, black	6898	6929
221	Shale, grayish-black, slightly calcareous	6929	7150
153	Shale, black, in part somewhat calcareous	7150	7303
53	Shale, black, calcareous	7303	7356
1	Shale, brown, micaceous; contains abundant minute pyrite crystals	7356	7357

Thickness Feet	Description of strata	Depth in feet Top	Bottom
	Onondaga formation, 199 feet		
23	Limestone, very fine, dense, very dark brownish-gray, argillaceous	7357	7380
81	Chert, brownish- to dark brownish-gray, somewhat calcareous	7380	7461
2	Chert, very dark brownish-gray, with some interbedded dark brownish-gray shale; both chert and shale contain some glauconite	7461	7463
71	Chert, very dark brownish-gray, with some interbedded dark brownish-gray shale	7463	7534
9	Shale, grayish-black	7534	7543
13	Chert, very dark brownish-gray, almost black, slightly calcareous, with considerable interbedded dark brownish-gray shale	7543	7556
	Lower Devonian series, 461 feet		
	Oriskany sandstone, 111 feet		
3	Sandstone, medium-grained, light gray, somewhat calcareous	7556	7559
38	Sandstone, fine- to medium-grained, light gray to gray, calcareous; some of quartz grains rounded and frosted	7559	7597
3	Sandstone, very fine-grained, dark gray, calcareous	7597	7600
18	Limestone, very fine crystalline, dark brownish-gray, sandy	7600	7618
5	Sandstone, fine- to medium-grained, light gray, somewhat calcareous	7618	7623
4	Limestone, very fine, crystalline, dark brownish-gray, sandy	7623	7627
12	Sandstone, fine-grained, gray, calcareous	7627	7639
10	Limestone, very fine, crystalline, dark brownish-gray, sandy	7639	7649
4	Sandstone, fine-grained, brownish-gray, calcareous	7649	7653
14	Limestone, very fine crystalline, dark brownish-gray, sandy and somewhat cherty; a few quartz grains well rounded	7653	7667
	Helderberg group, 350 feet		
19	Limestone, very fine, crystalline, silty	7667	7686
82	Limestone, very fine, crystalline, light to dark brownish-gray, silty and somewhat cherty; contains fragments of shells	7686	7768
56	Limestone, very fine, dense, very dark brownish-gray, silty; contains fragments of shells	7768	7824
72	Limestone, very fine, dense, very dark brownish-gray, argillaceous	7824	7896
5	Shale, black, very calcareous	7896	7901
20	Limestone, very fine, dense, black, argillaceous	7901	7921
67	Shale, black, very calcareous	7921	7988
29	Limestone, very fine, dense, brownish-gray to black, argillaceous and somewhat cherty; contains fragments of shells	7988	8017
	Upper Silurian series, 142+ feet		
20	Limestone, very fine, dense, dark brownish-gray, argillaceous, magnesian	8017	8037
20	Limestone, very fine, dense, brownish-black, silty, magnesian	8037	8057
23	Limestone, very fine, dense, dark brownish-gray, silty and argillaceous, magnesian	8057	8080
17	Limestone, very fine, crystalline, light brownish-gray, silty and argillaceous, magnesian	8080	8097
24	Limestone, very fine, dense, brownish-black, argillaceous, magnesian	8097	8121
38	Limestone, very fine, dense, gray to dark brownish-gray, silty and argillaceous, somewhat magnesian; contains a little chert	8121	8159
	Total depth		8159

The base of the Lower Mississippian series has been placed tentatively at the base of a prominent sandstone in which examination of the drill cuttings reveals the presence of conglomeratic layers with quartz pebbles up to at least, and probably more than, 10 mm. in diameter. The position of this horizon with respect to the Upper Devonian red beds and a prominent sandstone member

which occurs a short distance below them in the four wells from which drill cuttings have been examined, is shown in the following table:

Relation of base of Mississippian to Upper Devonian red beds, in feet.

	Snee and Piedmont No. 1	Heyn No. 1	Thompson No. 1	Indian Creek No. 1
Depth to horizon taken as base of Mississippian.	110	140	451	445
Interval between base of Mississippian and top of red beds.	122	215	278	153
Position of Upper Devonian red beds.	232–680	355–755	759–1107	598–1012
Thickness of Upper Devonian red beds.	448	400	348	414
Interval between base of Mississippian and top of sandstone member under red beds.	596	625	626	617
Position of prominent sandstone member under red beds.	706–792	765–845	1107–1212	1062–1150

It will be noted that the interval between the horizon selected as the base of the Mississippian and the top of the red beds varies considerably from well to well and that the thickness of the red beds is not constant. On the other hand, the interval between this horizon and the top of the prominent sandstone below the red beds remains fairly uniform. The variations noted are due largely to the dropping out in some of the wells of the thin red layers which are interbedded with greenish-gray ones in the upper portion of the interval occupied by the red beds. In the Piedmont well, the uppermost layer assigned to the red beds possesses a dark purplish-gray rather than the dark brick-red color exhibited by most of the red layers. Sandy shales of the latter color first appear 30 feet deeper.

The strata above the red beds assigned to the Upper Devonian are exposed on the west flank of Chestnut Ridge along the National Pike approximately halfway between Hopwood and Summit. The red beds at their base, however, are not exposed. Marine fossils are present. Willard[2] in 1933, on the basis of the fossils, correlated these beds with the lower Chemung of New York, which would indicate a hiatus of considerable magnitude in this area between the Devonian and Mississippian systems. Because no red beds are exposed at the surface, he concluded that the Catskill red beds of the Upper Devonian are absent. These observations were made before any drilling had been done in the vicinity. Caster[3] in 1935, challenged Willard's interpretation of the age of the fossils and placed these strata in the Conewango group, the uppermost division of the Devonian system in western Pennsylvania. Laird[4] recently has made a detailed study of this Upper Devonian inlier under the direction of Caster and has accumulated considerable additional evidence which corroborates Caster's interpretation. Also, he has found it possible to segregate certain beds from the basal "Pocono" which are the equivalent of the Knapp formation of northwestern Pennsylvania, now considered to be the lowermost representative of the Mississippian system in that area. The writer has not had an opportunity to examine Laird's measured outcrop sections and to tie them in with the well sections in the field.

[2] Bradford Willard. Chemung of southwestern Pennsylvania: Proc. Pa. Acad. Sci., vol. VII, 1933, pages 151-152.

[3] Kenneth E. Caster. Age of Devonian of southwestern Pennsylvania; Bull. Amer. Assn. Pet. Geol., vol. 19, 1935, pages 1547-1550.

[4] Wilson M. Laird. Devonian and Mississippian relations in southwestern Pennsylvania; (abstract): Bull. Geol. Soc. Amer., vol. 50, 1939, page 1983.

The interval between the top of the red beds and the top of the Tully limestone, a readily reeognizable horizon in the area, ranges from 5,605 to 5,668 feet in the four wells located approximately along the axis of the anticline. These wells are a maximum distance of 2.4 miles apart. In marked contrast, in the Thompson well, located 1,000 feet east of the Sorg No. 1, the interval jumps to 6,001 feet. In the Sorg it is 5,668 feet. It is not thought that the Thompson well is far enough southeast of the anticlinal axis to account for this increase in interval by the dip of the beds, or that the well deviates sufficiently from the vertical, particularly since the sample log of the Thompson well to a depth of 4,000 feet can be correlated fairly well with similar logs of the Heyn No. 1 and Sorg No. 1 wells. The dip would have to be 19° to account for the increased interval. It seems highly probable that somewhere between a depth of 4,000 feet and the top of the Tully limestone the Thompson well intersects a reverse fault which trends approximately parallel to the long axis of the Summit dome and dips toward the west. Faults of this type are common in the Oriskany sand pools of north-central Pennsylvania and south-central New York.[5] The interval of 5,828 feet between the top of the red beds and the top of the Tully in the Snee and Piedmont No. 1 well, 1,800 feet northwest of the Sorg No. 1 well on the northwest flank of the anticline, is also greater than that along the axis of the fold. In this case, however, it is thought that the well is located far enough down the flank that the dip of the beds, which would have to be only 13½°, accounts for most of the apparent increase.

The interval between the top of the Tully limestone and the top of the Onondaga formation at Summit ranges from 524 to 602 feet. In the well 2 miles southwest it is 674 feet. Seven miles farther southwest in the Paul Dunham well it is 881 feet. At least a portion of the increase in the latter well can be assigned to the increased dip of the beds. The interval of 5,900 feet between the top of the red beds and the top of the Tully, however, suggests that this well also may intersect a fault zone.

The Onondaga formation in the Summit area has 3 to 30 feet of dense dark argillaceous limestone at the top. The rest consists largely of a light to dark brownish-gray chert, in part silty and mostly noncalcareous. In the lower portion, considerable dark brownish-gray to black shale is interbedded with the chert. Occasional glauconitic zones are present. A thin but persistent seam of brown micaceous shale with abundant pyrite, which occurs at the top, resembles in every respect the brown shale observed at this horizon in the Tioga field of north-central Pennsylvania.[6] The Onondaga formation ranges in thickness from 184 to 199 feet in the five wells that have been drilled through it.

The Oriskany sandstone in the three wells completed through it has a thickness of 73, 95 and 111 feet. The top of this formation is readily recognizable but the base can be established only approximately from study of samples as it grades almost imperceptibly into a silty limestone of the Helderberg group. The Oriskany sandstone is calcareous throughout. Portions of it consist of sandy limestone rather than true sandstone.

In the Thompson well, the deepest in the area, 350 feet of limestones with minor amounts of interbedded shales in the lower part have been assigned to the Helderberg group, the base of the Devonian system having been placed tentatively at a depth of 8,017. In western Pennsylvania the line between lime-

[5] Charles R. Fettke. Oriskany as a source of gas and oil in Pennsylvania and adjacent areas: Bull. Amer. Assn. Pet. Geol., vol. 22, 1938, page 250.

[6] Charles R. Fettke. Physical characteristics of the Oriskany sandstone and subsurface studies in the Tioga gas field, Pennsylvania: Pa. Topo. and Geol. Survey, Bull. 102B, 1931, page 8.

stone of the Helderberg group and Silurian limestone can be determined from a study of well samples. The former is nonmagnesian, in part cherty, and frequently very fossiliferous. The latter usually is magnesian and non-fossiliferous or only sparsely so, and over most of the area anhydrite appears a short distance below the top. Although no anhydrite was observed in the 142 feet of limestone below 8,017 feet penetrated by the well, the limestone is decidedly magnesian in character.

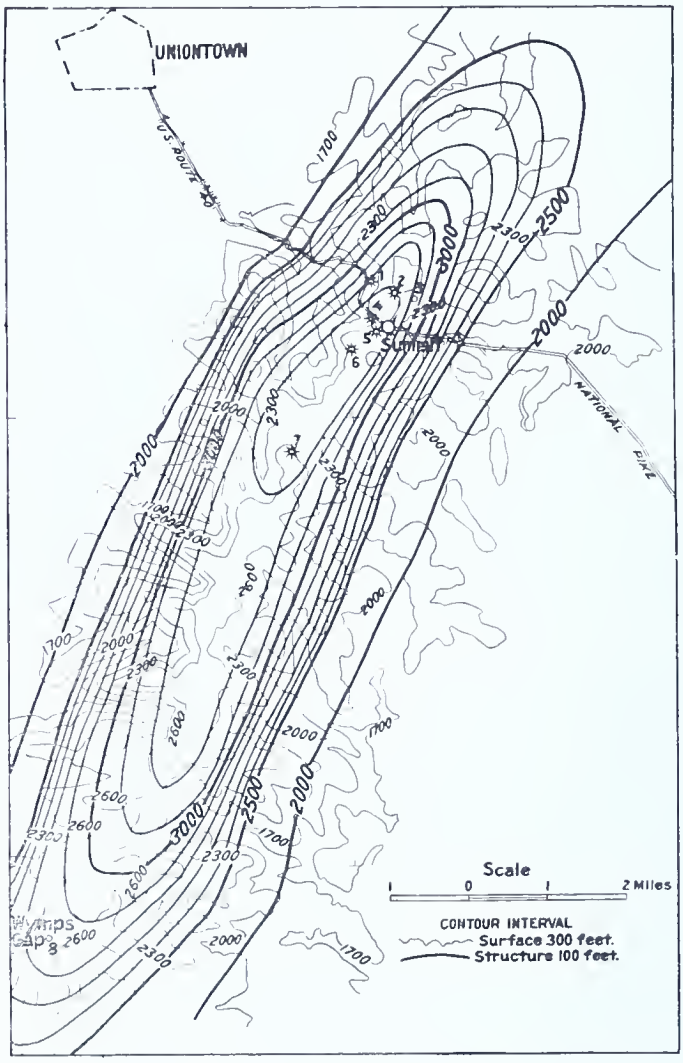

Figure 1. Map of the Summit gas pool showing relation of wells to topography and structure.

Structure

The Summit pool is on the crest of the Summit dome. This elongated dome along the axis of the Chestnut Ridge anticline with a closure of approximately 1,000 feet as mapped on the surface beds, is the most prominent structural feature in Fayette County.

In the well highest on the structure, the Piedmont No. 1 of the Peoples Natural Gas Company, the top of the Onondaga formation, from which the gas is obtained, is 4,141 feet below sea level. The average pitch in a northeasterly direction along the axis between this well and the Sorg No. 1 is 4.7 feet per 100 feet for 4,300

feet. In a southwesterly direction between it and the Indian Creek No. 1, the pitch is 1.7 feet per 100 feet for 8,500 feet.

The Snee and Piedmont No. 1 on the northwest flank of the dome was completed in January 1940. In this well, 1,800 feet northwest of the Sorg No. 1, the top of the Onondaga is 139 feet lower, indicating an average dip of 7.8 feet per 100 feet in that direction. This well, which found the top of the Onondaga 343 feet lower than in the highest well, is, at present, producing from lower on the structure than any other well.

On the southeast flank of the anticline in the Thompson No. 1 well, 1,000 feet east of Sorg No. 1, the top of the Onondaga is 470 feet lower than in the Sorg. This relatively abrupt drop probably is due to the presence of a reverse fault with a northwest dip and a strike approximately parallel to the long axis of the dome. Although the existence of this fault has not been definitely established in the outcropping strata, the results obtained in the Thompson well seem to indicate that production on the southeast flank of the dome can be expected to terminate along such a fault a relatively short distance southeast of the axis of the fold.

Reservoir rock

With the possible exception of the Sorg No. 1 well, all wells in the Summit pool are obtaining their production from the Onondaga formation. The first gas is obtained anywhere from 40 to 70 feet below the top of the formation and the flow increases at intervals until the bottom is reached. Several of the wells have not been completed through the entire thickness. The Heyn No. 1 well, drilled to a depth of 95 feet below the top of the formation (April 23, 1937), had an open flow capacity of 1,800,000 cubic feet per day. Early in the summer of 1939, after the open flow had declined to approximately 675,000 cubic feet per day, the well was drilled 23 feet deeper. Drilling was stopped when the open flow had increased to 6,900,000 cubic feet per day.

Unfortunately no cores of the pay portions of the Onondaga formation have been obtained and the drill cuttings are too fine to yield any definite information in regard to the nature and amount of the pore space. Some of the silty chert particles appear to contain minute pores. Occasional particles show slickensides and others are intersected by minute quartz veinlets, both of which suggest fracturing. It seems probable, therefore, that the pore space is partly primary and partly secondary.

Only one well, the Sorg No. 1, is reported to have obtained any production from the Oriskany sandstone, although two other wells within the pool have penetrated this formation. The Sorg well was completed only five feet in the sandstone, but in this interval its open flow approximately doubled. When the gas was turned into the line several months later, however, a drastic drop occurred and the amount actually obtained was more nearly in line with the open flow shown before the Oriskany was reached.

The Oriskany sandstone, which ranges in thickness from 73 to 111 feet in the area, is calcareous throughout. Portions of it consist of sandy limestone rather than true sandstone. Two cores, one 6½ inches long, and the other one inch, were obtained from the upper ten feet of the sandstone in the Peoples and Piedmont No. 1 well, drilled with rotary tools. These had total porosities of only 1.5 and 1.6 per cent by volume, respectively. Both contained considerable quantities of calcite cement.

Production and reserves

It is estimated that the Summit pool at the end of 1939 had produced approximately three billion cubic feet of gas. This includes the gas used for drilling

purposes and that which has been lost in drilling in the wells.[7] The original reservoir pressure of the pool was between 3,025 and 3,050 pounds per square inch. No accurate measurements of the extent to which this has declined have been made. On December 24, 1939, the Heyn No. 2 well, after being shut in for 22 hours, registered a pressure of 2,000 pounds per square inch. This well is midway between and 1,200 feet from two other wells which were not shut in at the time. It would appear, therefore, that at the end of 1939 the average reservoir pressure was still well over 2,000 pounds

All the wells drilled thus far in the area have been producers with the exception of the Thompson well and the Dunham well. Conditions in the Thompson well indicate that production on the southeast flank of the structure probably terminates against a fault a short distance southeast of the axis of the fold, and the Dunham well, seven miles southwest of the southernmost producing well, is far down the pitch in that direction. An effective closure of at least 340 feet has been demonstrated on the northwest flank. No salt water thus far has been encountered in any of the wells, but a little fresh water condenses from the gas, one measurement indicating about 6 gallons per 850,000 cubic feet of gas. The limits of the pool have not been outlined sufficiently to determine the total productive area.

Because of the relatively low permeability of the reservoir rock, as witnessed by the low initial open-flow capacities of the wells when compared with the Oriskany sand wells of north-central Pennsylvania and south-central New York, it is impossible to predict what the lowest pressure will be at which the wells will yield commercial volumes of gas. The ultimate recovery that may be expected from the Summit pool is difficult, if not impossible, to estimate at present. It is the first pool of its type to be developed in the State and too little is known concerning the nature of its reservoir rock to predict its behaviour.

Drilling costs

Of the eight wells completed in the area, seven have been drilled with cable tools and one by the rotary method. The approximate costs of five of these wells are as follows:

Leo F. Heyn No. 1	$108,000
Leo F. Heyn No. 2	56,000
Indian Creek Coal and Coke Co. No. 1	43,000
Snee and New Penn Development Corporation's Piedmont Coal Co. No. 1	35,000*
Peoples Natural Gas Company's Piedmont Coal Co. No. 1 (drilled with rotary tools)	75,000

* Estimated cost to complete through Onondaga. At time estimate was made well was drilling at 137 feet in this formation.

The high cost of the Heyn No. 1, the discovery well, was due to the fact that after reaching a depth of 6,633 feet, it had to be re-drilled, starting at 4,200 feet. It will be noted that the cost of drilling with cable tools has dropped sharply as more experience in the area has been gained. Running three "tours," except Sunday, about six months are required to complete a well with cable tools. In contrast, the well drilled with rotary tools was completed within 4½ months and the actual drilling time was only 82 days.

Other favorable structures in Fayette County

Although the Summit pool is the only one of commercial rank that has been

[7] Wm. E. Snee, Oral communication, January 4, 1940.

opened in the Onondaga formation in Pennsylvania (Jan. 1940), some gas has been encountered in this formation in at least two other localities. In 1920, an open flow of about 500,000 cubic feet of gas per day was obtained at a depth of 6,822 feet in the upper part of the Onondaga formation in the Booth and Flinn No. 1 well of the Peoples Natural Gas Company at McCance in Westmoreland County. The gas occurred in a cherty limestone a few feet below the Marcellus black shale of the Hamilton group. When an attempt was made several years later to deepen the well, salt water was encountered in a chert a short distance below the gas-bearing zone. Booth and Flinn No. 2, located about 500 feet from No. 1 and drilled to a total depth of 7,756 feet, encountered only a show of gas and no water in this zone. Although these wells are on the Chestnut Ridge anticline, they are not favorably situated with respect to the domes along its axis.

Wm. E. Snee and Potter Development Company's Indiana Savings and Trust No. 1 well on the Laurel Hill anticline in Fairfield Township in eastern Westmoreland County also encountered an open flow of about 500,000 cubic feet of gas per day in the cherty Onondaga formation. A little salt water entered the well from the lower part of the formation. After the Oriskany sandstone had been penetrated, the flow of water increased greatly.

It is not likely that the Summit pool represents the only occurrence of commercial quantities of gas in the Onondaga formation. Other domes along prominent folds, such as the Chestnut Ridge and Laurel Hill anticlines, in the area over which the Onondaga retains its cherty character, can be looked upon as favorable territory to prospect. At least two other domes of this type are present in Fayette County. One of these is along the Laurel Hill anticline in the northeastern part of Stewart Township. This structure is being tested (January 1940) by the Wm. E. Snee and New Penn Development Company's Gregg L. Neel No. 1 well. The other dome is along the Chestnut Ridge anticline in the southeastern part of Bullskin Township. Neither one of these domes, however, is as prominent a structural feature as the Summit dome. Their closures as mapped on the surface beds are considerably less.

Acknowledgment

The writer wishes to acknowledge the cooperation of Wm. E. Snee, New Penn Development Corporation, Greensboro Gas Company, Peoples Natural Gas Company, and W. W. Wasson and associates. To the officials of these organizations, the writer is indebted for the field data and the collection of samples upon which this report is based.